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THE IMPACT OF THE SMOKE FREE LAW ON THE NUMBER OF CAR CRASHES RELATED WITH ALCOHOL CONSUMPTION

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ABSTRACT

I study the effects of the changes on the tobacco control laws in the United States on the number of car crashes related with alcohol consumption. Understanding how these law changes affected the number of fatalities involving an alcohol-impaired driver can shed light on the link between alcohol and tobacco. I explore the timing of adoption in different states in a difference-in-differences framework to identify the results. I observe a significant decrease in alcohol related accidents two years after anti-tobacco policies, however this reduction seems not be associated with the smoke free laws in bars and restaurants because I also observe the same consequence in the number of car crashes not related with alcohol consumption. Thus, there is a reduction on the overall total car crashes after the application of the smoke free laws but it is not an unintended consequence due to the relationship between drinking and smoking.

Keywords: Car accidents, Smoke Free law, alcohol, Differences in Differences

1. INTRODUCTION

The smoke bans are not a recent event in our history, in fact the first restricting smoking occurs in 1575 in Mexico when Roman Catholic Church regulation banning smoking in any place of worship. In USA, since 1975 the states have applied a change in the law restricting the tobacco uses in public spaces, bars, restaurants and indoors buildings. Moreover, the number of USA states adhering to the law has grown tremendously since 2002. Nowadays 33 states have some kind of tobacco prohibition. The main reason to apply smoke free policies is the fact that, according to the World Health Organization, tobacco use is the number one cause of preventable death in the United States.

Another important bad consequences of smoking are the damages caused by second-hand smoke. According to studies from the Centers for disease control and prevention (2015) nowadays 16 million people in the USA suffer from smoking-caused illness which costs around $170 billion in health expenses every year and the estimates of the productivity losses are around $156.6 billion per year. Tobacco control laws may lead to a reduction of the health care costs and improve work productivity among many others benefits generating healthier environments and giving smokers incentive to quit.

In addition to all direct benefits, one potential unintended benefit of the application of tobacco control laws is a reduction on the number of car's accidents related with alcohol consumption. Several studies find evidence that alcohol and tobacco are complements[1]. According to Little (2000) there exist a co-dependence between alcohol and tobacco: individuals addicted to tobacco are four times more likely to be addicted to alcohol. In addition, alcohol dependents are

[1] Koksal; Wohlgenant (2011), Cameron; Williams (2001), Decker and Schwartz, (2000)

three times more likely than to be smokers. According to Funk et al (2007) alcohol and tobacco might act on common mechanisms in the brain, which could explain the link between tobacco and alcohol. These authors also reinforce the genetic, biological and environmental factors that contribute for the co-dependence.

In this context, I will study if, in addition to reduce the first cause of preventable deaths in the United States, smoke free policies can lead to a reduction in the number of car crashes as an unintended consequence of the law. The idea behind it is that the tobacco use restrictions laws could decrease, via complementarity between smoking and drinking, consumption of alcohol, which in turn decreases the number of car fatalities involving drivers with alcohol consumption. This is important because a reduction on the number of car crashes involving an alcohol-impaired driver, which corresponds to 40% of the total of accidents in US, means also a decrease on the annual expenses alcohol-related crashes ($51 billion per year).

I exploit the staggered nature of the implementation of tobacco control laws across states in a Differences-in-Differences framework to identify the results. I find a significant decrease in alcohol related accidents two years after anti-tobacco policies, however this reduction seems not be associated with the smoke free laws in bars and restaurants.

This paper is organized in four sections other than this introduction. In the following section I will present a current literature of this topic. Having addressed previous studies, I will go on to the methodology and the data treatment. The main results will be presented and will be discussed in session 5. Finally, the analysis and the effectiveness of the change in law as the future works are presented in the final considerations.

2. LITERATURE REVIEW

There has been much interest in the consequences of smoking and drinking for the society because of the huge cost in the expenses in health, losses in productivity and losses in lives. Research and speculation on the link between alcohol and tobacco have been showing that these drugs are correlated and can be seen as a complementary goods. Decker and Schwartz (2000) find that the higher alcohol prices lead to a decrease in both alcohol and smoking consumption. Cameron and Williams (2001) used data from the National Drug Strategy Household Surveys to analyze the cross price effects in alcohol and tobacco: their results also suggest that tobacco and alcohol are complementary goods, meaning the consumer would use both drugs together. Fertig el al (1995) brings together a series of papers showing evidence of biological and psychosocial mechanisms of alcohol-tobacco joint use.

Regarding the application of the anti-tobacco laws seems to be a lot of controversy. On the one hand, those who support these laws justify their importance using scientific evidence that secondhand tobacco smoke cause serious illnesses, the reduction on the private and public health expenses, the improvement in the workers' productivity and health, and the decrease in the number one cause of preventable death in the United States. On the other hand, smokers advocate their concern about loss of personal freedom and the excessive governmental power. I do not attempt to discuss which side should be supported. Rather than focus upon this controversy, my intention is identify the impact of the law in an unintended consequence.

Most of the papers on smoke free policies which can be found in the literature pertain to health and economic issues. Considering the US population, Klein at al (2009) and Siegel el al (2014) found that youth living in areas with anti-tobacco laws in bars and restaurants were less likely to initiate smoking compared with those youth who lived in areas without the restrictions

and enforcement of smoke free polices. Callinan el al (2010) review 50 studies to estimate whether smoking bans policies could reduce the effects on health of consumers and secondhand smokers. Their conclusions point out that anti-tobacco laws can lead to a reduction in exposure to the secondhand smokers. Although this review couldn't find a significant evidence of the effectiveness of those laws on the reduction of the number of the smokers, it identifies a downward trend in tobacco consumption.

Regarding the economic impact of smoking bans, many studies show no evidence of a negative impact of these bans on bars and restaurants' revenues. Kayani et al (2012) study 11 cities in Missouri in the period before and after the law change and find no change or increased taxable sales in bars and restaurants. Also, Loomis et al (2013) analyzed 9 states where the anti-tobacco laws were approved and their study shows that those laws had no economic impact on bars and restaurants[2].

Other authors analyze the smoke free law impact on other countries and cultures. For instance, Jones at al (2011) analyses the implementation of the smoking restrictions' laws in Scotland and England and find a limited effect on the total level of smoking. However, they find evidence that light smokers and older individuals are less affected by the laws and identify a reduction in consumption of tobacco among female heavy and moderate smokers and male heavy smokers.

Regarding the impact of the law in an unintended consequence such as the number of car crashes, there is only two studies that addressed this specific consequence. The first one found that the implementation of the smoke ban in bars and restaurants increase 13% the number of fatal

[2] Alabama, Indiana, Kentucky, Mississippi, Missouri, South Carolina, Texas, and West Virginia

crashes associated with alcohol consumption[3]. However, there are some important limitations from this study such as not considering the states that pass the law prior to 2000 and also omitted from the data counties with no car crashes related with alcohol consumption. The second study is from Bernat et al (2013) and analyze the time series effects from 1982 to 2008 in California and New York. They limited their data considering only two US states that enact a statewide smoking ban in restaurants and bars. The authors find no evidence that the smoke free laws affect the number of car crashes related with alcohol consumption. This paper extends this research building a dynamic panel considering all US states and all car crashes fatalities (related and not related with alcohol consumption) and applying a different methodology in order to identify whether the law was able to cause any impact on the number of car crashes.

3. DATA AND RESEARCH DESIGN

3.1 Sample and Data Sources

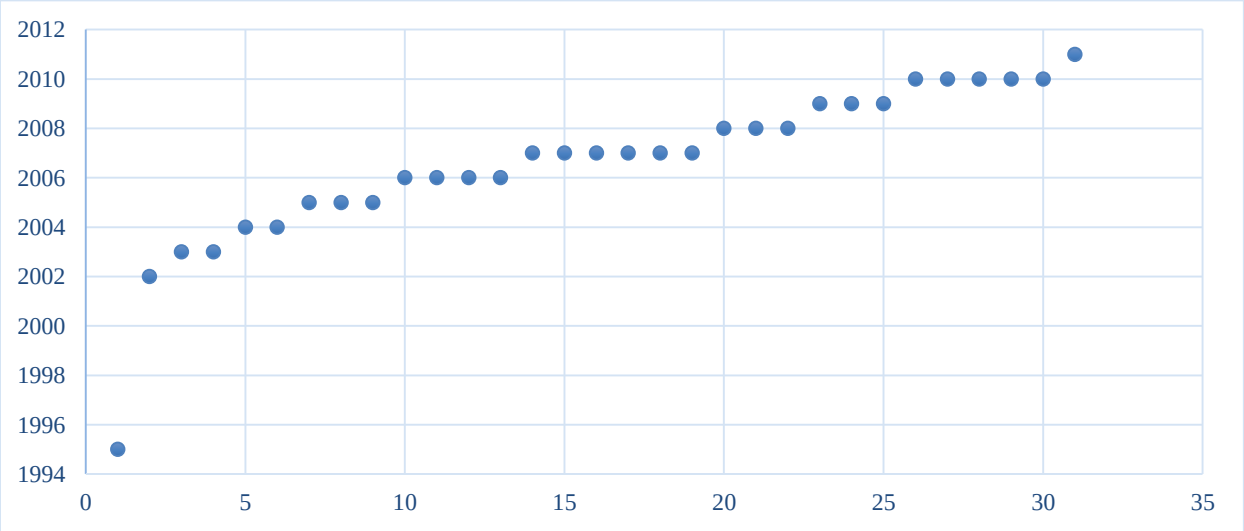
In this work is used data on the number of car crashes related with alcohol consumption in the USA's states from 1994 and 2011 from the National Highway Traffic Safety Administration (NHTSA). I am focusing in accidents in which the highest levels of blood alcohol concentration (BAC) of all drivers involved is 0.08 % or higher. The official tables for USA are available from 1994 until 2011. The data on the year adoption of smoke free laws across different states comes from the American Nonsmokers' Rights Foundation (ANRF). Also, in this period there is no change regarding the laws about driving under influence of alcohol.

[3] Adams; Cotti (2008)

I restrict my sample to states that changed the law prior to 2011[4]. This restriction allows me to analyze if the application of the law cause any change in the behavior of the drivers. Restrictions vary from state to state, but here I am only considering statewide smoke bans on restaurant and bars. The timing of the application of the smoke free law vary among states.

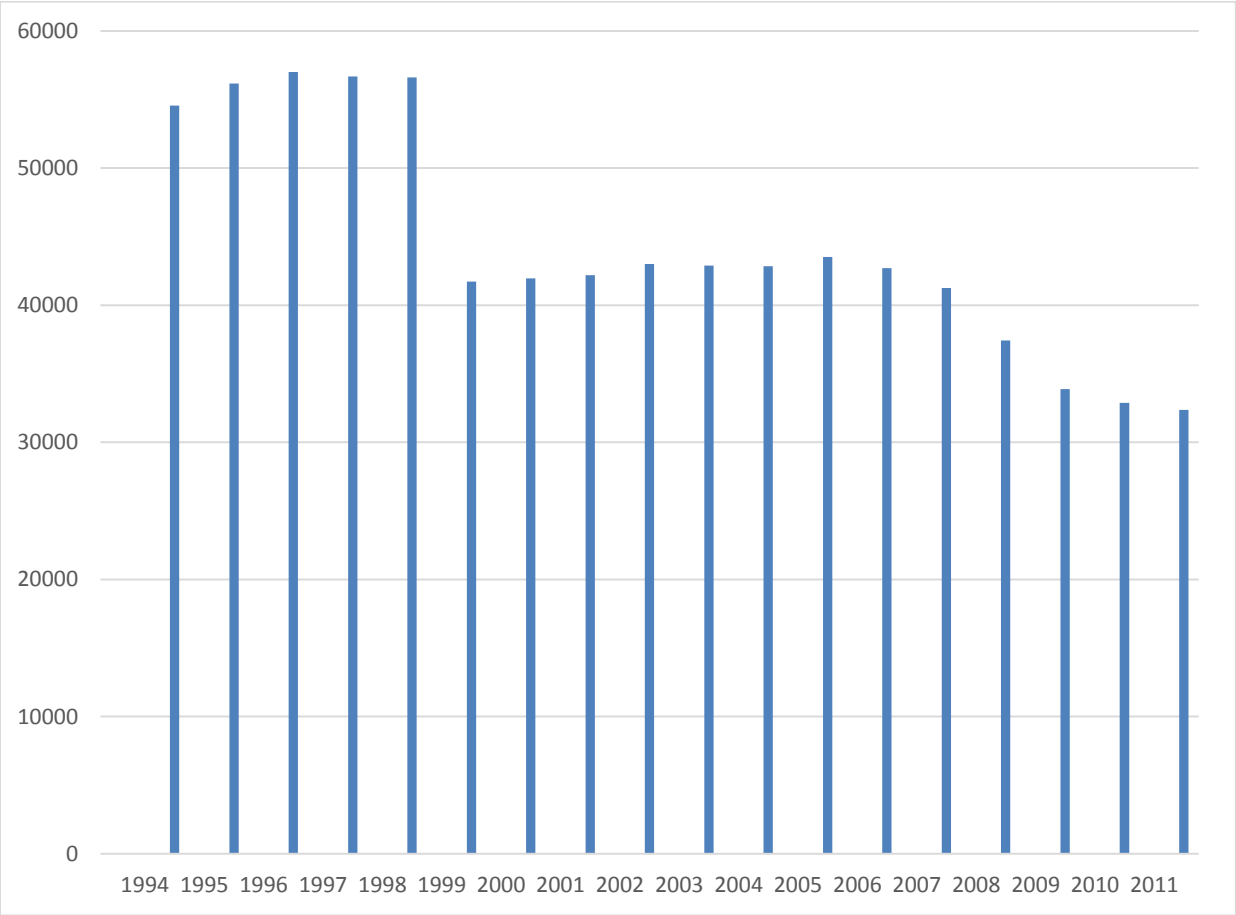
Figure 1 shows the distribution of the states that apply the anti-tobacco polices through the years. We can notice that the law enforcement has been gradually included in the US states. It is also important to notice that, with few exceptions, the law enforcement occurred within a few years between 2002 and 2011. Therefore, controlling for the numbers of years since law change significantly reduces the variation in the data which deters from identifying the results. The problem is that for most of the states the change in the law occurs in the same year, and then it is not possible to isolate possible annual trends. Figure 2 shows the number of car crashes between 1994 and 2011. There is a negative trend in the number of accidents, which is similar to the trends in cigarette consumption.

Figure 1- Distribution of the states that apply the anti-tobacco policies: 1994 to 2011



[4] The restriction is due to availability of data from National Highway Traffic Safety Administration.

Figure 2 - Number of car fatalities in US States between 1994 and 2011[5]



In this context I build a dynamic panel where I have the control and treated groups. The control group are the states that did not pass the Smoke Free act Law and the treated group are the states that enforced Smoke Free Laws. I exploit the staggered nature of the enforcement of these laws and use both states that never adopted these laws and treated states before the adoption in the control group. Table 1 show those states and also the year of the application of the law for the treated group.

[5] National Highway Traffic Safety Administration data

Table 1- Control and Treated Groups

Treated Group	year of the smoke free law	
California	1995	Alabama
Delaware	2002	Alaska
Connecticut	2003	Arkansas
New York	2003	Florida
Maine	2004	Georgia
Massachusetts	2004	Idaho
Rhode Island	2005	Indiana
Vermont	2005	Kentucky
Washington	2005	Louisiana
Colorado	2006	Mississippi
Hawaii	2006	Missouri
New Jersey	2006	Nevada
Ohio	2006	Oklahoma
Arizona	2007	Pennsylvania
District of Columbia	2007	South Carolina
Minnesota	2007	Tennessee
New Hampshire	2007	Texas
New Mexico	2007	Virginia
Utah	2007	West Virginia
Illinois	2008	Wyoming
Iowa	2008	
Maryland	2008	
Montana	2009	
Nebraska	2009	
Oregon	2009	
Kansas	2010	
Michigan	2010	
North Carolina	2010	
South Dakota	2010	
Wisconsin	2010	
North Dakota	2011	

I also use the data on unemployment, percentage of female, percentage of individuals that finished college, income per capita and population from the U.S. Census Bureau (2009 and 2010) and Bureau of Economic Analysis (1969 to 2013) to include as control variables in my analysis.

3.2 Research Design

I employ a Difference-in-Differences (DID) research design to identify the impact of the smoke free law on the number of car crashes related with alcohol consumption. Difference-in-Differences approach is particularly useful for estimating causal effects in panel data when certain groups of observations are exposed to the causing variable and the other group are not. Also, using DID we can control for other variables which may reduce the residual variance. The outcomes are observed for two groups and for two time periods: Treated group: the group that is exposed to the treatment, is equals one and; Control group: the group equals zero if treatment does not occur. Period $y_{-t;}$: the years before the application of the law; Period $y_{+t;}$: the years after application of the law; Period y : the year when the law is applied. The control and treated groups and the years of the application of the law are presented in table 1. Here the states that apply the smoke free policies in bars and restaurants are the *treated group* and the others states are the *control group*.

The dynamic panel data are available before and after the treatment and not all states receive the treatment. Since we are observing the same states within a group for each time period, we can remove any simultaneous confounding factors that might be affecting both treated and control states. The average increment from the control group is subtracted from the average increment in the treatment group.

I run the following regression specification:

$$y_{i,t} = \sum_{j=-2}^{2} \beta_{ij} D_j + X_{i,t} + \mu_i + \delta_t + \epsilon_{i,t}$$

where:

y_{it} is the number of car crashes in state *i* in the year *t*; δ_t is a time-specific fixed effect; μ_i is a state-specific fixed effect; *j* are the year related with the smoke free law adoption such that j = - 2 is two years prior to the law implementation, j = - 1 is one year before the law implementation, j = 0 is the year of its implementation and j = 1, 2 is one year and two years after the law implementation, respectively. β_{ij} are the event year treatment effect; D_j are event year dummies. In tables 2 and 3 D_j is the variable Smoke Free law ^{j}.

For instance, $D_{-2} = 1$ for states that passed the law, two years prior to the law implementation and zero otherwise. $D_0 = 1$ for states that passed the law, on the year of its implementation and so forth. $X_{i,t}$ is a set of control variables including: unemployment, percentage of female, percentage of individuals that finished college, income per capita and population.

D_{-2} and D_{-1} are included to test whether or not the data shows any pre-tends between treatment and control. If there is no significant difference between the number of car crashes related with alcohol consumption before the application of the law and in the year of the application of the law, we can conclude that there were no differences between treated and control groups prior to the law change. On the other hand, D_1 and D_2 are included in the regressions to test whether the law had an impact in the years after its adoption.

We define the dependent variable as the percentage of the number of car crashes per year: $\Delta y_{it} = \frac{y_{i,year\ of\ the\ application\ of\ the\ law} - y_{i,before}}{y_{i,before}}$. Thus, the Differences-in-Differences (DID) estimator, $\hat{\beta}$ is is given by:

$$\widehat{\beta} = \frac{\overline{y_{1,ylc} - y_{1,yblc}}}{y_{1,yblc}} - \frac{\overline{y_{0,ylc} - y_{0,yblc}}}{y_{0,yblc}}$$

Where yblc stands for the year before law change and ylc means the year of the law change. Thus, $\bar{y}_{yblc}$ is the average of the number of car crashes related with alcohol consumption in the year before the law change; $\bar{y}_{ylc}$ is the average of the number of car crashes related with alcohol consumption in the year of the law change. Also, 1 is the treatment group and 0 is the control group. I include one specification with state fixed effects using the logarithm of the car crashes as the dependent variable. In this case, the control variables used do not have variation in time-series and since the regressions with the logarithm are always included the states fixed effects, controls end up being absorbed. In addition to that, I also run the same regressions for the number of car crashes not related with alcohol consumption in order to compare the results and check if there exist any factor other than the change in the law which may affect the number of car crashes.

3.3 Discussion and Robustness check

I am controlling for time varying characteristics of the states that might be relevant for my problem. For instance, unemployment, percentage of female, percentage of individuals that finished college, income per capita and population. The idea is to control for permanent effects, it means remove specific characteristics from states to analyze the effect on the number of accidents related with alcohol consumption caused by the change of the law.

One possible issue with my estimates is that the errors might not satisfy the homoscedasticity conditions of the OLS regressions. In order to correct for this possibility all the standard errors presented are corrected for heteroskedasticity and serial correlation. This is necessary to calculate the standard errors properly and eliminate independence over time and level of accidents. In addition, the errors in each state over the years might be correlated. I cluster the standard errors by states in order to correct for this possibility.

4. MAIN RESULTS

The Differences-in-Differences estimator for the impact on car's accidents in the year of the implementation of the law is not significant. Since the regression in the year of the change in law does not show the impact, I also run a regression considering the two years before and two years after the enforcement of the law.

Table 2 presents the estimates of a dynamic panel with leads and lags of the effect of the changes on the tobacco control laws in the United States on percentage of the number of car crashes related with alcohol consumption.

Column (1) presents the results without the state controls. Column (2) presents the results including state controls. In column (3) are the results from the impact including controls and year fixed effect for each state. Column (4) presents the results using state fixed effect. The dependent variable in column (4) is the logarithm of the number of car crashes. In most of the specifications I do not find any significant change either in the previous years of the anti-tobacco policies or in the year of the adoption of the law. This is important to guarantee that the results in the paper are not affected by any pre-existing trend.

Column (1) shows a significant decrease in the number of car fatalities, around 18% less (6.9% one year after and 11.4% two years after). However, when I included control variables, in order to remove some features from states, the significant reduction appears only after the second year. Also, the results are stronger when the year fixed effect and the state fixed effect are considered: the number of accidents decrease 22%.

Furthermore, the results show that there is no significant impact in the year of the change in law, but only two years after the implementation. These results could be explain by the fact that in this model I'm not considering the month of the implementation, so the year after the change would be the first full year of the impact and this is why we might capture the impact only after this year. For example, the effective date of the adoption of the smoke bans in Delaware and Ohio are December of 2002 and December of 2006, respectively. Moreover, even after the change in law, it is possible that the policy enforcement would take a while which lead bars and restaurant to not enforce the law, trying to keep clients. In this sense, individuals have continue smoking until bars and restaurants got tickets for it and begun enforcing the law inside their property. For instance, if any bar or restaurant violated the smoke ban three times within a year in New York

City, their business's license may be revoked. In addition there is a possibility of period of adaptation and these could be the transition period for the law to be effective enforced.

Table 2: The impact of the smoke free law on the number of car crashes related with alcohol [6]

VARIABLES	percentage of the number of car crashes per year (1)	percentage of the number of car crashes per year (2)	percentage of the number of car crashes per year (3)	log of accidents of the number of car crashes per year (4)
Smoke Free law $^{-2}$	0.008	0.015	0.022	-0.040
	(0.196)	(0.331)	(0.473)	(-0.966)
Smoke Free law $^{-1}$	-0.013	-0.012	-0.013	-0.045*
	(-0.310)	(-0.252)	(-0.290)	(-1.692)
Smoke Free law ^{0}	-0.020	-0.006	-0.006	-0.039
	(-0.521)	(-0.148)	(-0.154)	(-1.128)
Smoke Free law $^{+1}$	-0.069*	-0.047	-0.042	-0.063
	(-1.747)	(-0.948)	(-0.853)	(-1.484)
Smoke Free law $^{+2}$	-0.114***	-0.117***	-0.118***	-0.161***
	(-3.489)	(-2.852)	(-2.879)	(-3.705)
income per capita		-0.103***	-0.009	0.200
		(-2.995)	(-0.149)	(0.352)
log population		-0.010*	-0.009	-
		(-1.780)	(-1.472)	
% complete college		0.004***	0.001	-
		(3.745)	(0.617)	
% female		0.784	1.375*	-
		(1.034)	(1.829)	
unemployment		-0.965*	-1.857***	-4.220***
		(-1.888)	(-2.960)	(-2.981)
Year Fixed Effects	No	No	Yes	Yes
State Fixed Effects	No	No	No	Yes
R-squared	0.016	0.043	0.081	0.296
Observations	714	450	450	450

[6] Smoke Free law ^{j} is a dummy equal to one if the year is the year before (after) the application of the law, and zero otherwise. For j=0 it means it is the year of the application of the law. The difference in the number of observations is due to the inclusion of the lags in the regression and controls. Robust t-statistics are in parentheses *, **, *** indicate significance at 10%, 5% and 1% level, respectively.

At first, these findings suggest that in general the application of the law could have a positive correlation with number of car crashes related with alcohol consumption. It is also interesting to notice that unemployment has a significant negative correlation in all regressions. The reason for this is not clear from the data, but it may have something to do with the fact that unemployment cannot afford the gas and so reduce or substitute driving.

In order to analyze whether the decrease in car accidents is indeed due to the smoke bans, or to some other confounding factor, I also run the same regressions to see what happen with the annual traffic fatalities involving drivers with no alcohol consumption. Table 3 shows DID estimates of the effect of the changes on the tobacco control laws in the United States on percentage of the number of car crashes not related with alcohol consumption. As the previous table, column (1) presented the results without the state controls and other columns presented the impact with more control variables. In column (2) are presented the results including state controls. In column (3) are the results from the impact considering the year fixed effect for each state and column (4), the results using state fixed effect. Similar to Table 2, in all regressions I do not find any significant correlation either in years prior to the adoption of the law or in the year of the law. The significant correlation only appears 2 years after the application of the smoke free law. These results show that after two year of the adoption of the smoke free law, the number of car fatalities, in which the drivers had not consumed alcohol before their crash, decrease.

The findings in this work suggest that after two years of the enforcement of the tobacco controls law there is a significant reduction in the total number of car crashes, related and not related with alcohol consumption. However, the findings of my study do not imply that the adoption of the smoke free laws is the variable responsible for those results because could have been some confounding variables that this study may failed to control or eliminate.

Table 3: The impact of the law on the number of car crashes not related with alcohol[7]

VARIABLES	percentage of the number of car crashes per year (1)	percentage of the number of car crashes per year (1)	percentage of the number of car crashes per year (2)	log of accidents of the number of car crashes per year (3)
Smoke Free law $^{-2}$	0.006	-0.021	-0.023	-0.023
	(0.266)	(-0.893)	(-0.941)	(-0.876)
Smoke Free law $^{-1}$	-0.003	-0.021	-0.023	-0.040
	(-0.113)	(-0.623)	(-0.696)	(-1.498)
Smoke Free law ^{0}	0.007	0.009	0.010	-0.020
	(0.250)	(0.302)	(0.309)	(-0.756)
Smoke Free law $^{+1}$	-0.002	-0.016	-0.013	-0.024
	(-0.078)	(-0.686)	(-0.565)	(-1.064)
Smoke Free law $^{+2}$	-0.061**	-0.074**	-0.067**	-0.076**
	(-2.364)	(-2.218)	(-2.150)	(-2.239)
income per capita		-0.144***	-0.050	0.023
		(-4.114)	(-1.299)	(0.062)
log population		-0.005	-0.007**	-
		(-1.638)	(-2.402)	
% complete college		0.004***	0.002	-
		(3.906)	(1.431)	
% female		0.578	0.627	-
		(1.220)	(1.413)	
unemployment		-0.857***	-0.800	-2.358**
		(-3.350)	(-1.413)	(-2.169)
Year Fixed Effects	No	No	Yes	Yes
States Fixed Effects	No	No	No	Yes
R-squared	0.005	0.073	0.113	0.713
Observations	714	450	450	450

[7] Smoke Free law ^{j} is a dummy equal to one if the year is the year before (after) the application of the law, and zero otherwise. For j=0 it means it is the year of the application of the law. The difference in the number of observations is due to the inclusion of the lags in the regression and controls. Robust t-statistics are in parentheses *, ** , *** indicate significance at 10%, 5% and 1% level, respectively.

I should stress that my study has been primarily concerned with the impact on the change on smoke laws on the number of car fatalities related with driver who had consumed alcohol and my hypothesis was the fact that since alcohol and tobacco are complements, the application on the law could impact these type of accidents. Nevertheless, my findings cannot read as evidence for these purpose.

In my study I am unable to identify causal effects prohibiting smoking inside bars and restaurants on the number of car accidents in which alcohol is presented in the blood of the people involved. My conclusion corroborates with Bernat et al (2013)'s paper which analyze a time series finding no evidence that the smoke bans affect the number of car crashes related with alcohol consumption.

5. FINAL CONSIDERATIONS

Smoking kills more people than alcohol, AIDS, car accidents, illegal drugs, murders, and suicides combined and there are studies showing that smoke free laws are related with lower smoking rates across drinking subgroups. Furthermore, studies have shown empirical evidence that alcohol and tobacco are complementary goods.

In this context, this work had the aim of exploring whether there exist a correlation between those kind of laws and the annual number of car fatalities in which the driver have consumed alcohol. My intention is to reveal if there is an unintended consequence of the smoke free laws and possibly reinforce the support for these policies.

My study is unable to identify causal effects on the smoke bans on the number of car crashes related with alcohol consumption. The outcomes suggest that after two years of the

adoption of the smoke free laws there is a significant decrease in the overall number of car crashes, including the fatalities related and not related with alcohol consumption. In this framework, the findings of my study do not imply that the adoption of the smoke free laws is the variable responsible for these results because could have been some confounding variables that this study may failed to control or eliminate. However, even though my results could not identify a link between the consumption of alcohol and the adoption of the smoke bans, the results point out that the overall number of car accidents diminishes in the US's states. The results are important because they indicate the possibility that could be another event occurring close to the adoption of the anti-tobacco laws or even an event related with those laws that could impact the number of car fatalities. One possible explanation here is that the states are investing more in awareness programs about drugs and driver safety. In this sense, future research should usefully focus in identify and measure if public policies of awareness and information (driver safety and drugs campaigns) could be more effective than restriction policies to achieve the desired results: reduce the consumption of drugs (tobacco and alcohol) and also to decrease the number of car crashes.

Although the conclusions are consistent with previous research from Bernat et al (2013), this study is the first one to provide evidence for all US states which applied smoke bans till 2011. In addition, this work has taken into account and applying a different methodology in order to identify an unintended consequence of the impact of control tobacco policies. The findings of my study are limited to US data and due to data limitation my results are subjected to the criticism of external validity. I can only hope that my results will be valid outside the United States in a country with a different culture and a different relation between, alcohol, smoke and driving.

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